SPECIFICATION

TITLE

"X-RAY ARRANGEMENT AND OPERATING METHOD FOR COMPENSATING SCATTERED RADIATION"

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention concerns a method for operating an x-ray arrangement to compensate scattered radiation, the x-ray arrangement being of the type having two x-ray systems each having an x-ray source and a radiation detector. The invention also concerns an x-ray device of this type having two x-ray systems.

Description of the Prior Art

An x-ray device of the general type described above is known as a biplane x-ray device, which is configured for cardiological or neurological examinations and treatment of patients. Due to the configuration of the x-ray device with two x-ray systems, it is possible to acquire two x-ray exposures, practically simultaneously from different angles, of a body region of a patient. This serves primarily to acquire spatial information of this body region.

A problem exists, however, with the interacting influences of the two x-ray systems due to the x-ray scattering from the body of the patient. This scattered radiation is weaker energy x-ray radiation that is scattered from the body of the patient in all directions during the irradiation of the patient since the body is not uniform. This scattered radiation does not convey any useful image information. The scattered radiation has the disadvantageous effect

that the image quality of the x-ray image acquired by the x-ray system is degraded. The scattered radiation disrupts the detection in the x-ray system, which emitted the x-rays from which the scattered radiation results. The largest part of the scattered radiation, however, proceeds back in the direction of the x-ray source of this x-ray system. If the x-ray source of an x-ray system is located near the x-ray detector of the other x-ray system, the disruption between the two x-ray systems is particularly significant.

In a biplane x-ray arrangement with each employing an x-ray image intensified as the x-ray detector, it is comparatively simple to suppress the scattered radiation, because one x-ray system is always switched "blind", i.e. unreceptive to x-rays, while the other x-ray system is in operation. This has the disadvantage, however, that only temporally displaced x-ray exposures of a patient can be acquired with the two x-ray systems of the biplane x-ray device. A further disadvantage of this technique is that the possibility to switch blind is not present in x-ray detectors of the solid state type, fore example aSi detectors. In this case, operation must be undertaken with a reduced image rate in both x-ray systems, which constrains the operator. The effective image rate that would otherwise be available thus is too high to select as the useable image rate, which means the systems must be operated below their technical capabilities.

Radiation converters in the form of solid-state detectors and x-ray image intensifiers are described in German OS 198 42 474, which can be configured in biplane x-ray devices. The radiation converters have an illumination layer that emits light upon being struck by radiation, in particular

x-ray radiation, this illumination layer being arranged as a controllable layer that is substantially radiation permeable over its entire surface in a first activation state, and in another activation state it is radiation permeable over its entire surface. Scattered radiation influences or radiation not generated by the appropriate radiation emitter can be excluded from the signal evaluation in this manner, so the image quality can be improved. In simultaneous operation of two x-ray systems (for example, in a biplane x-ray device), however, the influence of the scattered radiation cannot be excluded in this manner.

In German Patent 195 05 283, from which an x-ray examination device with two imaging systems with a-Si:H detectors is known, the problem is noted that scattered radiation from the patient also unavoidably reaches the detector of the second system during operation of the first system, and produced undesired interactions in the image from that detector. The solution suggested therein is to charge the a-Si:H detectors with x-ray pulses in alternation, between which the image readout ensues, so the x-ray pulse for one detector is in the pause between the readout of two half images of the other detector. The noise component arising due to scattered radiation contributions is determined by forming the difference between the two half images and subtracting this value from the rows of the total image.

SUMMARY OF THE INVENTION

The present invention is to provide a method and an x-ray device of the type described cited above, wherein the influence of scattered radiation on the image quality is at least reduced.

This object is achieved in accordance with the invention in a method and an x-ray device wherein a subject is irradiated by the x-ray source of the first x-ray system when the x-ray systems are at a specific position relative to one another, and a first x-ray scattered radiation image based on the x-ray radiation scattered by the subject is acquired for the second x-ray system by the x-ray detector of the second system, the x-ray source of which is not operated during the operation of the x-ray source of the first system. In the same position of the x-ray systems relative to one another, the subject is irradiated by the x-ray source of the second x-ray system and a second x-ray scattered radiation image based on the x-ray radiation scattered by the subject is acquired for the first x-ray system by the x-ray detector of the first x-ray system, the x-ray source of which is not operated during the operation of the x-ray source of the second system. The x-ray scattered radiation images acquired in this manner are saved (stored) in order to subtract the saved second x-ray scattered radiation image from an x-ray image acquired with the first x-ray system, or to subtract the saved first x-ray scattered radiation image from an x-ray image acquired with the second x-ray system, during simultaneous, partially displaced or completely displaced operation of the two x-ray systems. The influence of the scattered radiation originating from the second x-ray system on the x-ray image acquired by the first x-ray system is at least reduced, if not eliminated completely.

In an embodiment of the invention, the x-ray scattered radiation images are acquired and saved under defined conditions for each x-ray system. The x-ray scattered radiation images are then appropriate for the image correction,

as long as the acquisition conditions for the acquisition of a subject, as well as the acquisition of subsequent x-ray images of a subject, remain unchanged. The acquisition conditions include the x-ray dosage, the x-ray spectrum, as well as the acquisition geometry. Since the x-ray scattered radiation images are actually proportional to the x-ray dosage, it is possible, given a change of the x-ray dosage for the acquisition of further x-ray images, to scale an x-ray scattered radiation image that is used for the subtraction corresponding to the change of the x-ray dosage. In this manner, it is not necessary to accept and save all new x-ray scattered radiation images upon a change of the x-ray dosage, in order to compensate for the scattered radiation in the acquired x-ray images of a subject.

In a further embodiment of the invention, in order to determine the x-ray scattered radiation image used by an x-ray system for subtraction, a number of x-ray scattered radiation images are acquired for the x-ray system and are averaged. The averaging over a number of x-ray scattered radiation images has the advantage that the statistical noise in the resulting x-ray scattered radiation image is reduced, so the image quality is improved. The statistical noise of an x-ray scattered radiation image can also be reduced by a low-pass filter, since substantially only low frequency components are present in x-ray scattered radiation images.

DESCRIPTION OF THE DRAWINGS

Fig.1 is a schematic illustration of an x-ray device with two x-ray systems operable in accordance with the invention.

Fig. 2 is a timing diagram for operating of the x-ray device shown in Fig. 1 according to a first embodiment.

Fig. 3 is a timing diagram for operating of the x-ray device shown in Fig. 1 according to a second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The x-ray device schematically shown in Fig. 1 has two x-ray systems 1 and 2 that, in the exemplary embodiment, are adjustable around a patient P positioned on a schematically indicated patient positioning device 3. The x-ray system 1 has an x-ray source 4 as well as an x-ray detector 5, and the x-ray system 2 has an x-ray source 6 as well as an x-ray detector 7. The x-ray source 4 and the x-ray detector 5 as well as the x-ray source 6 and the x-ray detector 7 each are preferably arranged on a C-arm (not shown). The x-ray source 4 and the x-ray source 6 each emit a conical x-ray beam. In the exemplary embodiment, the x-ray detectors 5 and 7 are solid-state detectors. The x-ray systems 1 and 2 are connected to a calculating device 8. The calculating device 8, which controls the operation of the x-ray device, is additionally connected to memory 9 of the x-ray device.

In the operation of the x-ray device, x-ray exposures of a body region of the patient P can be acquired practically simultaneously from different angles with the two x-ray systems 1 and 2. As explained above, the scattered radiation which is emitted from the body of the patient P in all directions disadvantageously affects the quality of the x-ray recordings of the body region of the patient P acquired with the x-ray systems 1 and 2. The origin of the weaker energy x-ray radiation 11 scattered n the body of the patient P is

illustrated in Fig. 1 for the operation of the x-ray system 1, by an x-ray radiation beam 10 being emitted from the x-ray source 4 toward the direction of the patient P, as well as toward the x-ray detector 5. As can be seen in Fig. 1, although the scattered radiation 11 is not uniform, it nevertheless radiates in all directions as well as in the direction of the x-ray detector 7 of the x-ray system 2. The scattered radiation 11 contributes no useful information for the acquisition of x-ray images with the x-ray detector 7. Furthermore, the image quality if the x-ray recordings acquired with the x-ray detector 7 is degraded by the scattered radiation 11. The same is true for scattered radiation which strikes upon the x-ray detector 5 of the x-ray system 1, when an x-ray beam is emitted from the x-ray source 6 of the x-ray system 2 in the direction of the patient P and the x-ray detector 7.

In order to at least reduce the negative influence of the generated scattered radiation on the imaging by the two x-ray systems 1 and 2, the patient P is irradiated with the x-ray source 4 of the x-ray system 1 with the two x-ray systems 1 and 2 being in a specified position relative to one another, and a first x-ray scattered radiation image is acquired based on the radiation scattered from the patient P with the x-ray detector 7, with the x-ray source 6 not being in operation during the irradiation by the x-ray source 4. This first x-ray scattered radiation image is caused by the calculating device 8 to be stored in the memory 9 as a correction image for the x-ray detector 7. Given the same position of the x-ray systems 1 and 2 relative to one another, the patient P is irradiated with the x-ray source 6 of the x-ray system 2, and a second x-ray scattered radiation image based on the radiation scattered from

the patient P is acquired by the x-ray detector 5, which is a correction image for the x-ray receiver 5. This image also is stored by the calculating device 8 in the memory 9. The x-ray source 4 of the x-ray system 1 is not in operation during the irradiation of the patient P with the x-ray source 6.

Preferably, a number of such x-ray scattered radiation images are acquired for the two x-ray detectors of the x-ray systems 1 and 2, and are averaged, such that a resulting x-ray scattered radiation image is obtained which exhibits reduced statistical noise, for each x-ray system.

If x-ray exposures of a body region of the patient P are thus simultaneously acquired with the two x-ray systems 1 and 2 during operation of the x-ray device, the x-ray images acquired with the x-ray detector 7 can be improved with regard to their quality by subtracting the first x-ray scattered radiation image saved in the memory 9 from those exposures. Likewise, the x-ray images acquired with the x-ray detector 5 can be improved in quality by subtraction of the second x-ray scattered radiation image saved in the memory 9 therefrom. The subtraction of an x-ray scattered radiation image from an x-ray image acquired by one of the two x-ray detectors 5 and 7 is implemented by the calculating device 8. The x-ray images corrected in this manner can be supplied in a known manner to a display device (not shown) for visualization.

Normally, x-ray scattered radiation images for the two x-ray detectors 5 and 7 are determined and stored in the memory 9 for different positions of the x-ray systems 1 and 2 relative to one another in the previously described manner. The determination of the x-ray scattered radiation images thereby

ensues according to defined acquisition conditions, such as x-ray spectra, x-ray dosages, and acquisition geometries. If, given the same position of the x-ray systems 1, 2 relative to one another and an unchanged position of the patient P on the patient positioning device 3, only the x-ray dosage changes, then no new x-ray scattered radiation image must be determined. Since the x-ray scattered radiation images are proportional to the x-ray dosage, a scaling of the x-ray scattered radiation images corresponding to the change of the x-ray dosage can ensue, and the respective x-ray scattered radiation images required for the subtraction can be determined in this manner.

Two exemplary timing diagrams for the operation of the x-ray systems 1 and 2 as well as for the determination of x-ray scattered radiation images are illustrated in Figs. 2 and 3. As can be seen from Fig. 2, the x-ray systems 1 and 2 are operated by the calculating device 8 such that simultaneous x-ray exposures of a body region of the patient P are acquired. As shown in Fig. 2, the x-ray source 6 is temporarily not operated for the determination of the x-ray scattered radiation image relevant to the x-ray detector 7. The same is true for the x-ray source 4 during the determination of the x-ray scattered radiation image relevant to the x-ray detector 5.

As is shown in Fig. 3, x-ray scattered radiation images also can be determined given temporally displaced operation of the two x-ray systems 1 and 2, since the scattered radiation has influence in this operation as well on the image quality of the x-ray images determined by the two x-ray systems 1 and 2. As a rule, x-ray scattered radiation images for the correction of the x-ray images determined by the two x-ray systems 1 and 2 therefore are also

acquired dependent upon the type of operation of the x-ray device, i.e. with regard to the temporal displacement of the acquisition of x-ray images.

The invention has been described based on the example of an x-ray device having two x-ray systems. The inventive method also can be implemented with an x-ray arrangement with two x-ray devices capable of being operated independently of one another.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.